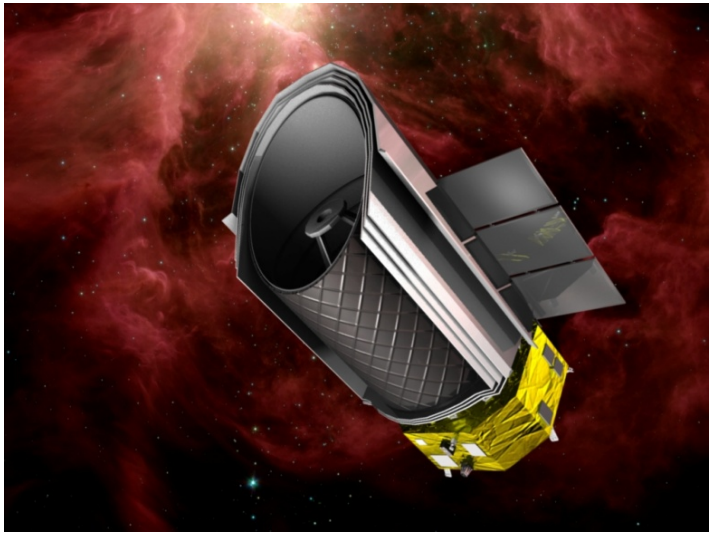

The next-generation
Infrared astronomy mission
SPICA
Space Infrared Telescope for Cosmology and Astrophysics
Star-formaton vs
Black Hole growth:
Synergy between
IXO an SPICA
April 29, 2010
Takao Nakagawa (ISAS/JAXA)
JAXA
宇宙航空研究開発機構
Japan Aerospace Exploration Agency
esa

SPICA
Space Infrared Telescope for Cosmology and Astrophysics

What is SPICA ?



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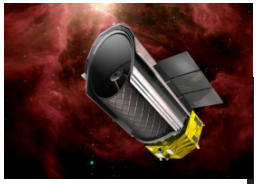
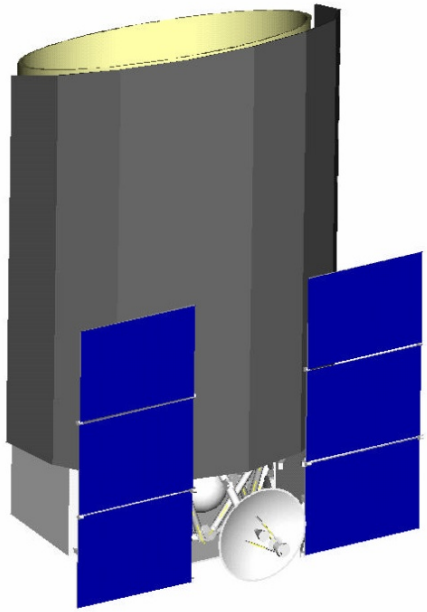
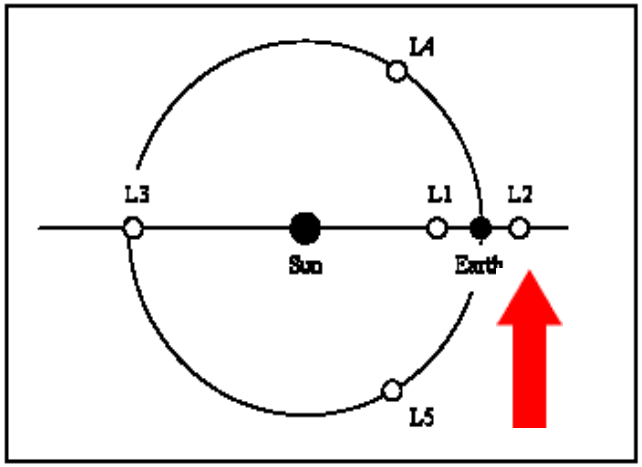


SPICA Mission Overview



- Specifications
  - Telescope: 3m-class, 6 K
    - Revolving CIB at its energy peak
    - Direct detection of exoplanets
  - Core wavelength: 5-210 μm
    - MIR Instrument
      - Including Coronagraph
    - Far-Infrared Instrument (SAFARI)
  - Orbit: Sun-Earth L2 Halo
  - Mission Life
    - 3 years (nominal)
    - 5 years (goal)
    - No expendables
  - Weight: 3.7 t
  - Launch: FY2018 (H-IIA)



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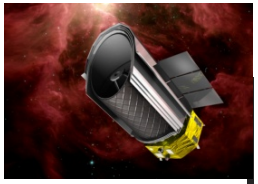
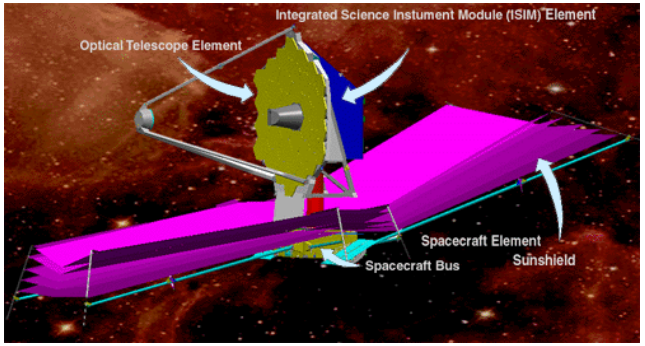


Herschel & JWST

Herschel
2009 Launched
3.5 m, 80 K
FIR-Submm



JWST
2014 Launch
6.5 m, ~ 40 K
NIR-MIR

T > 20K

↓

Wanted !
Cooled
Telescope

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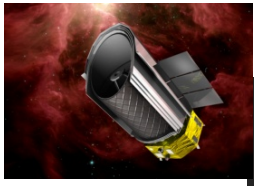
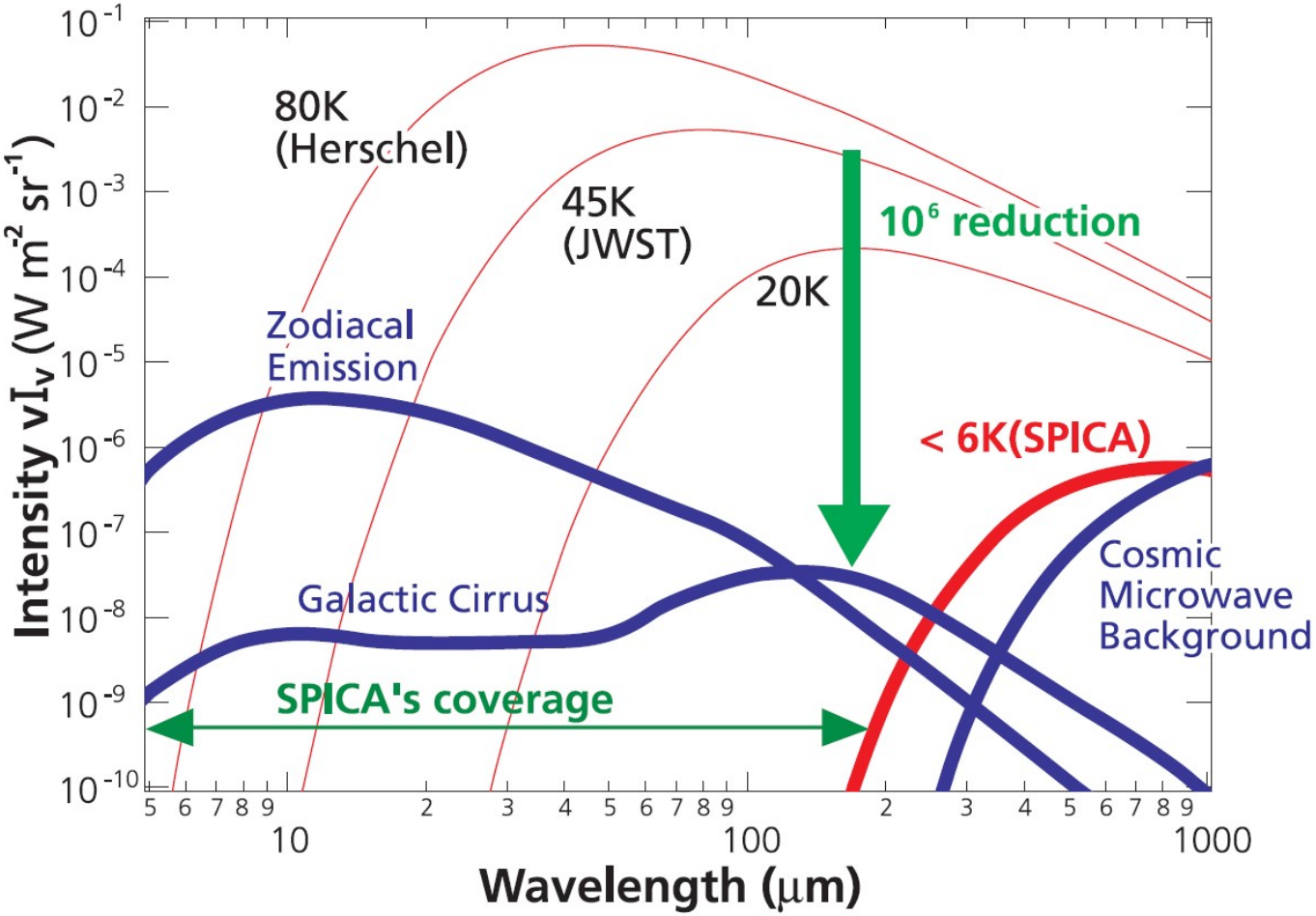


Cool ! Telescope



Reduction of BG by 10^6 -> Improvement of Sensitivity by 10^3

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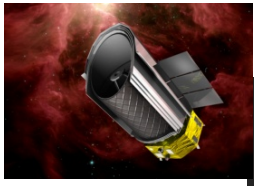
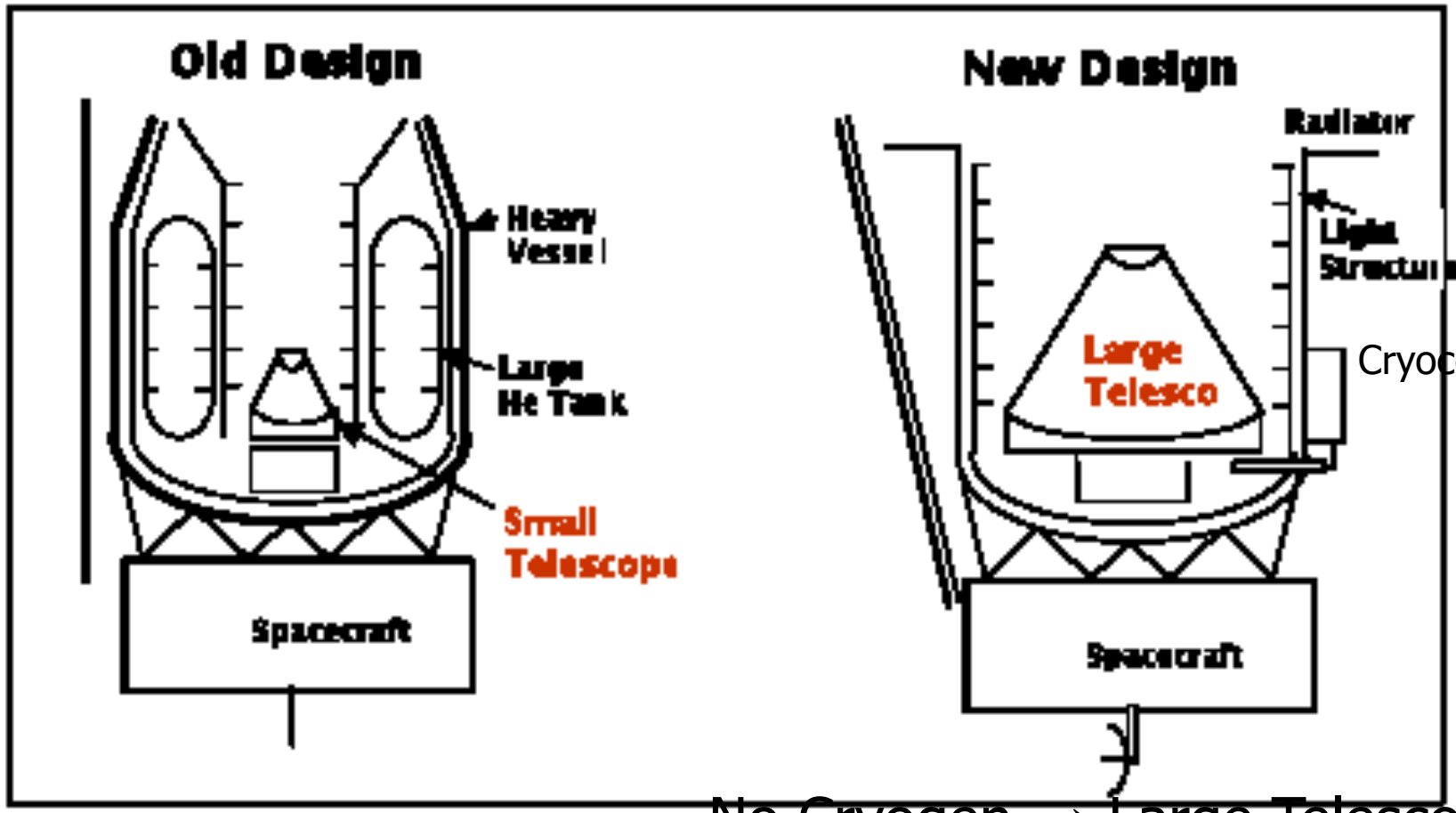


Revolution of Design Philosophy



Cryocoolers

No Cryogen → Large Telescope

ISO: 2.6t for 60cm → SPICA 3.7t for 3.2m

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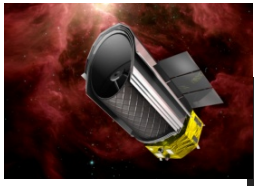
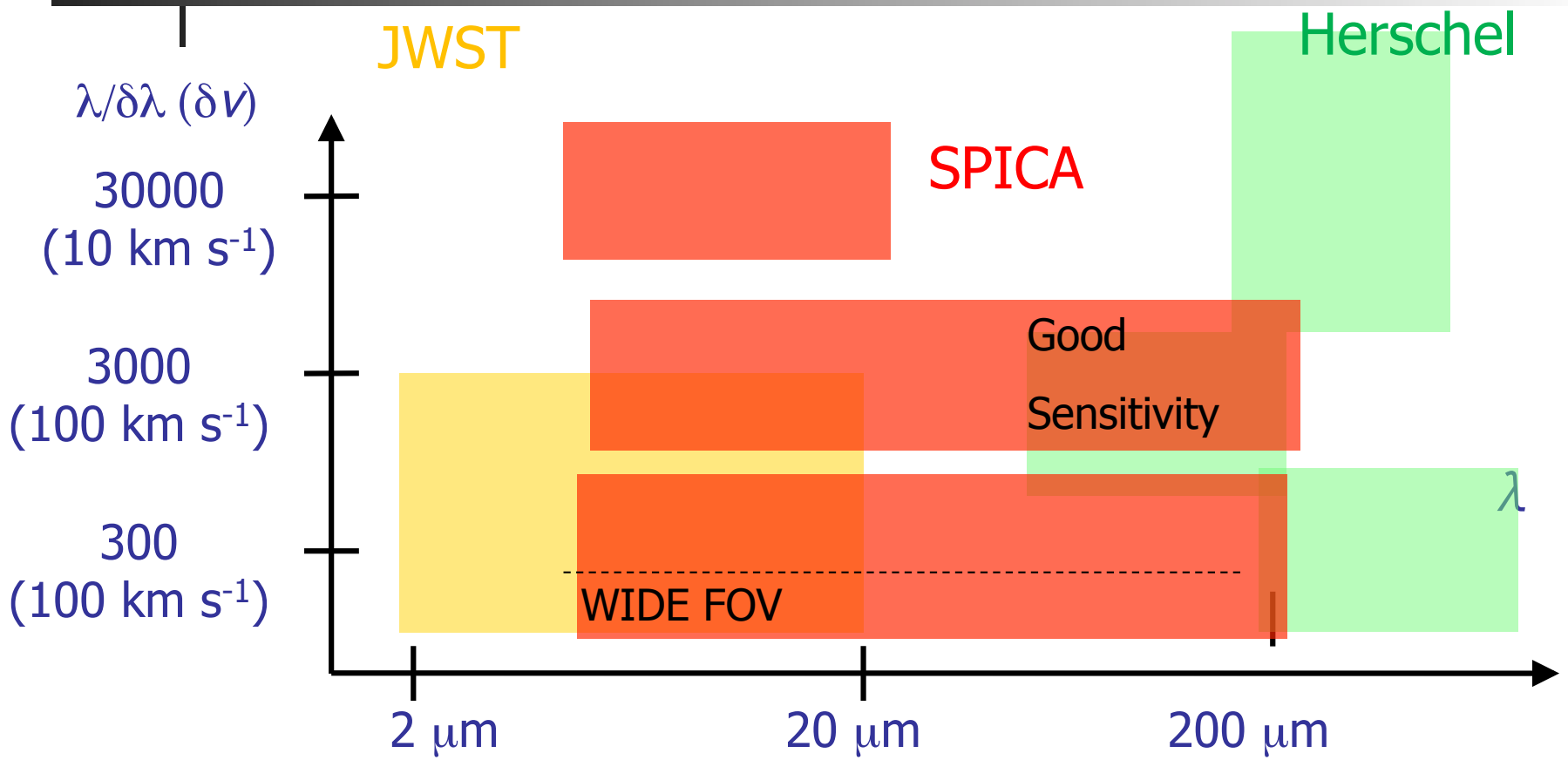


Focal Plane Instruments



Unique Instrument optimized for mid- and far-infrared

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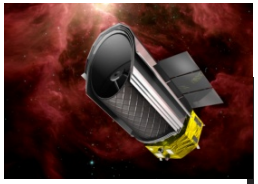
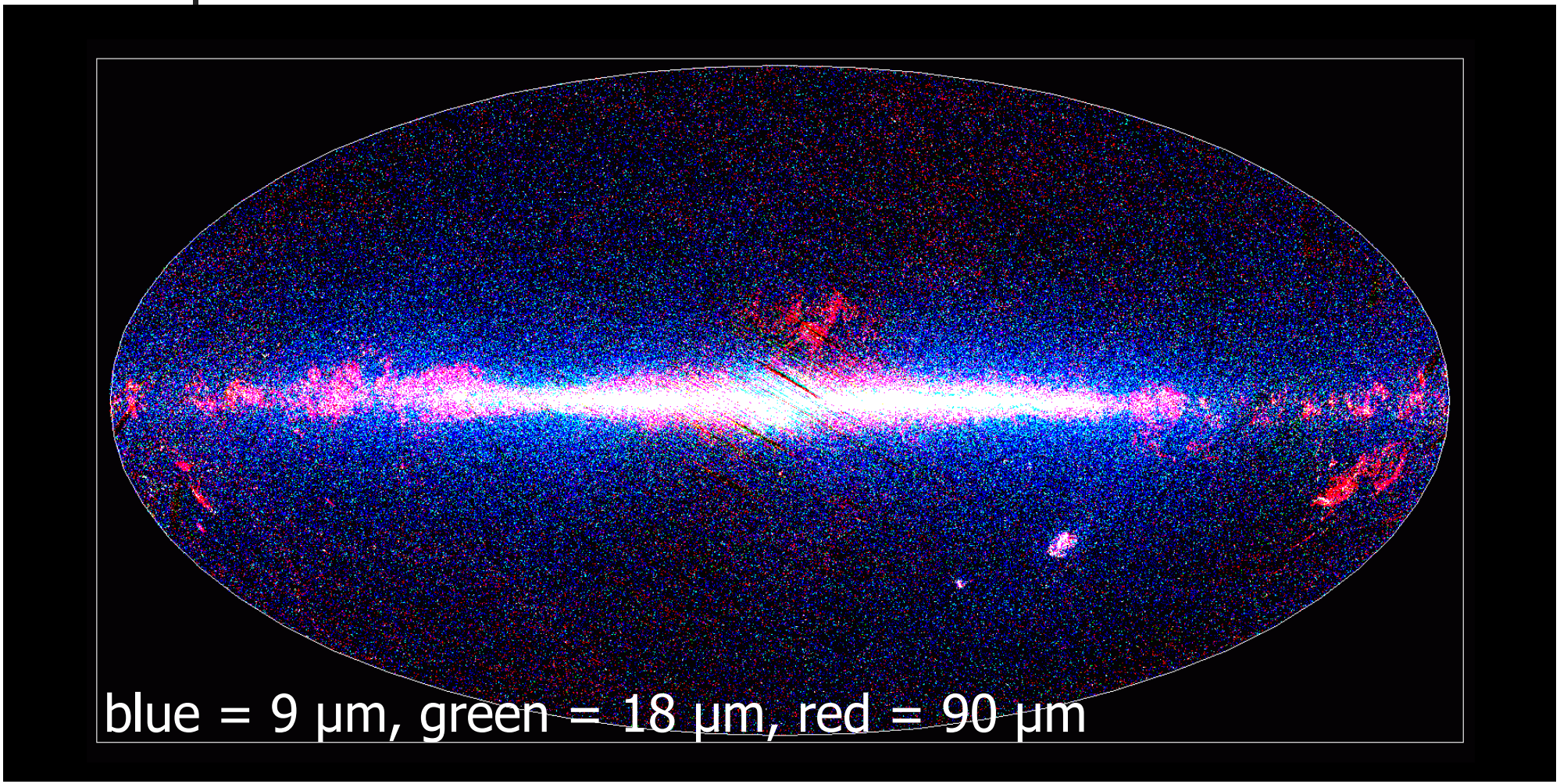


Ideal Input Catalog by AKARI



More than one million sources (Europe-Japan collaboration)

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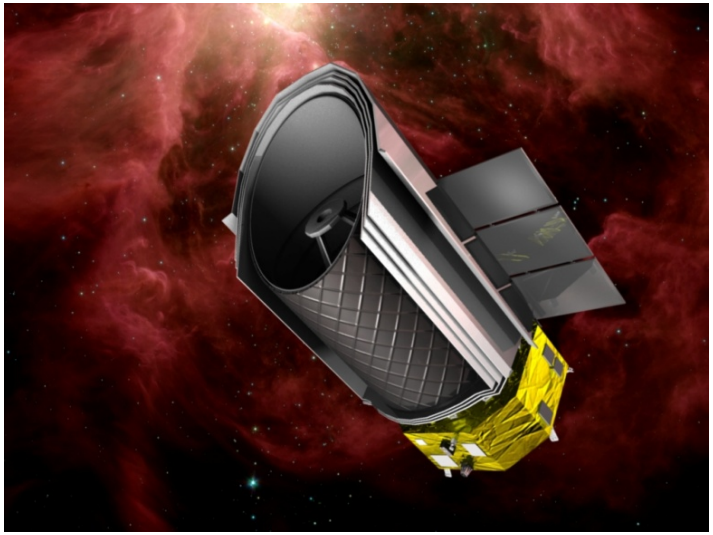
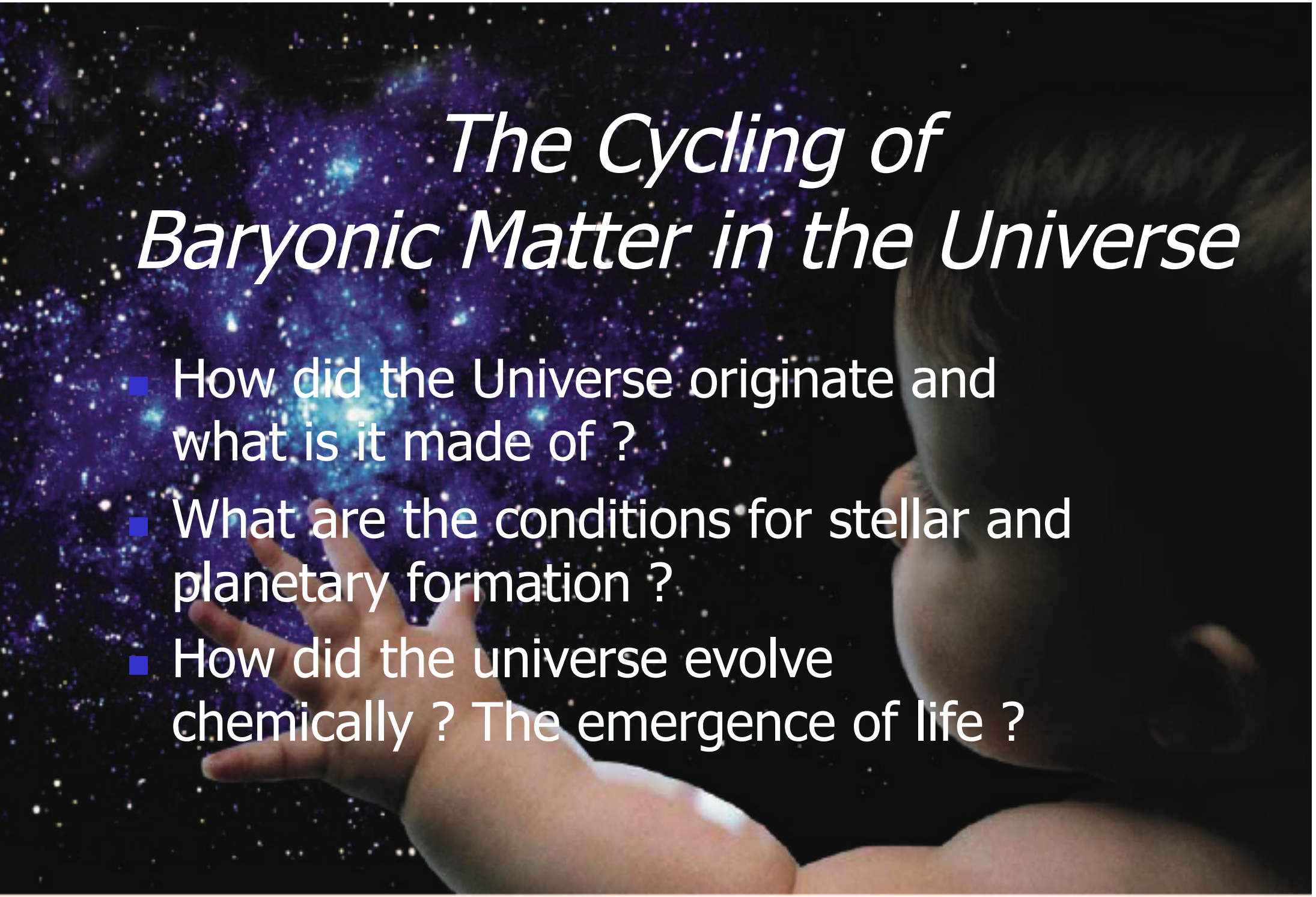
Scientific Capability of SPICA and synergy with IXO





The Cycling of Baryonic Matter in the Universe

- How did the Universe originate and what is it made of ?
- What are the conditions for stellar and planetary formation ?
- How did the universe evolve chemically ? The emergence of life ?

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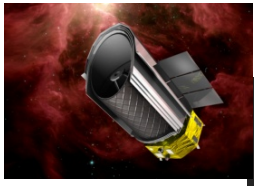
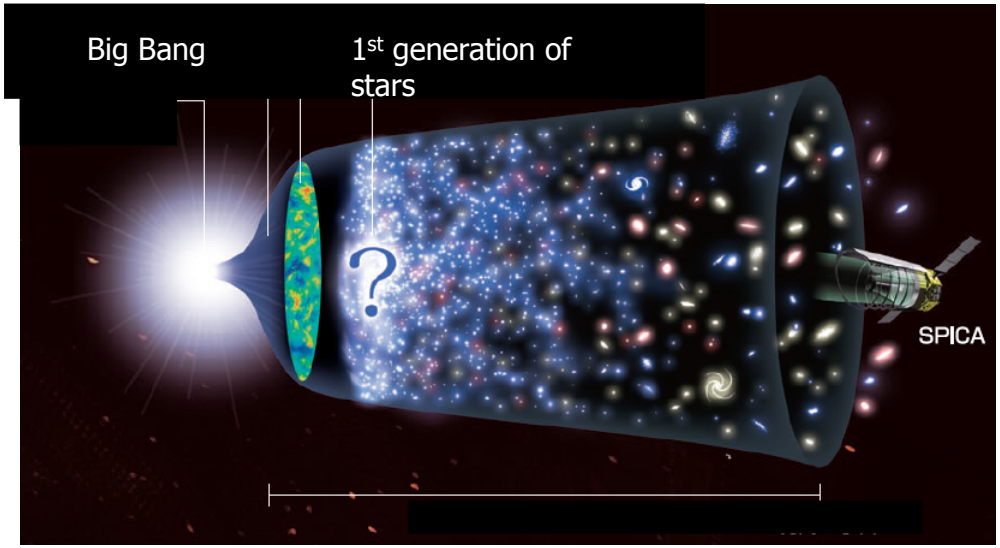
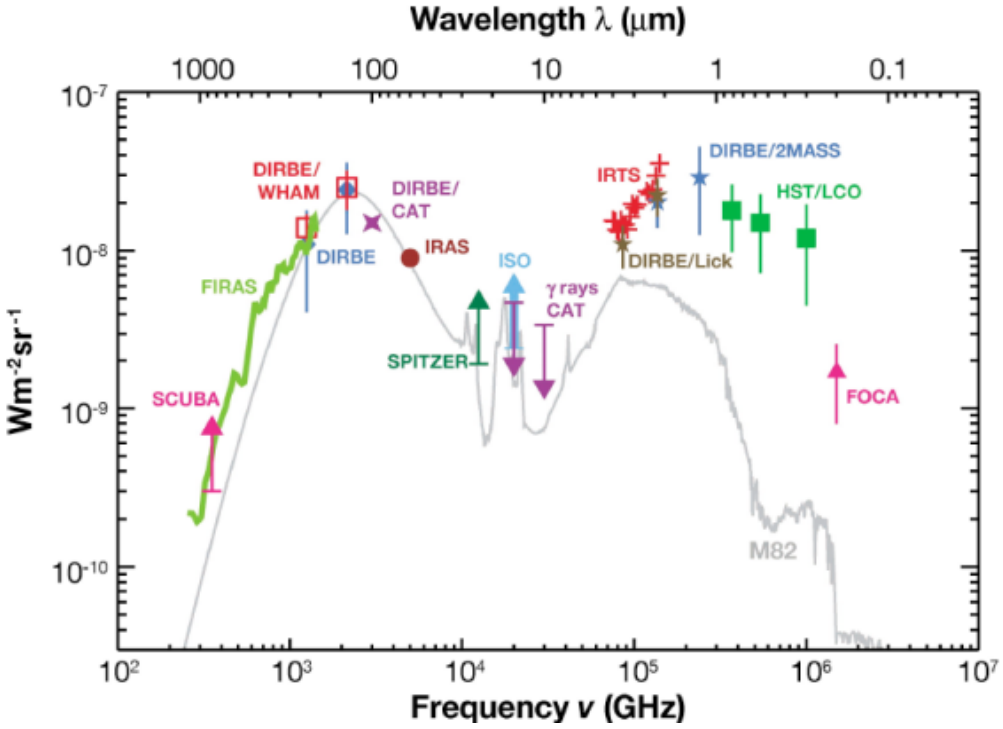


Scientific Goals (1/3)

- How did the Universe originate and what is it made of ?
  - Importance of IR observations





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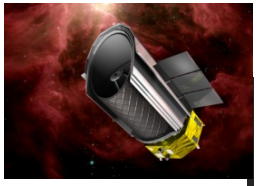
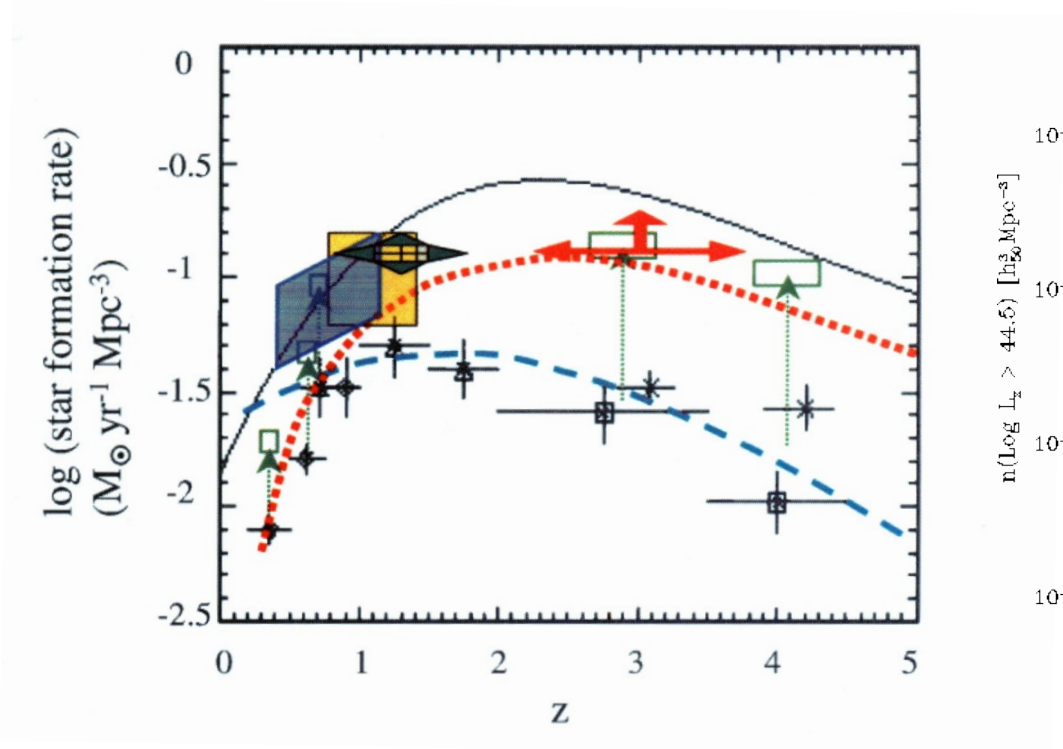
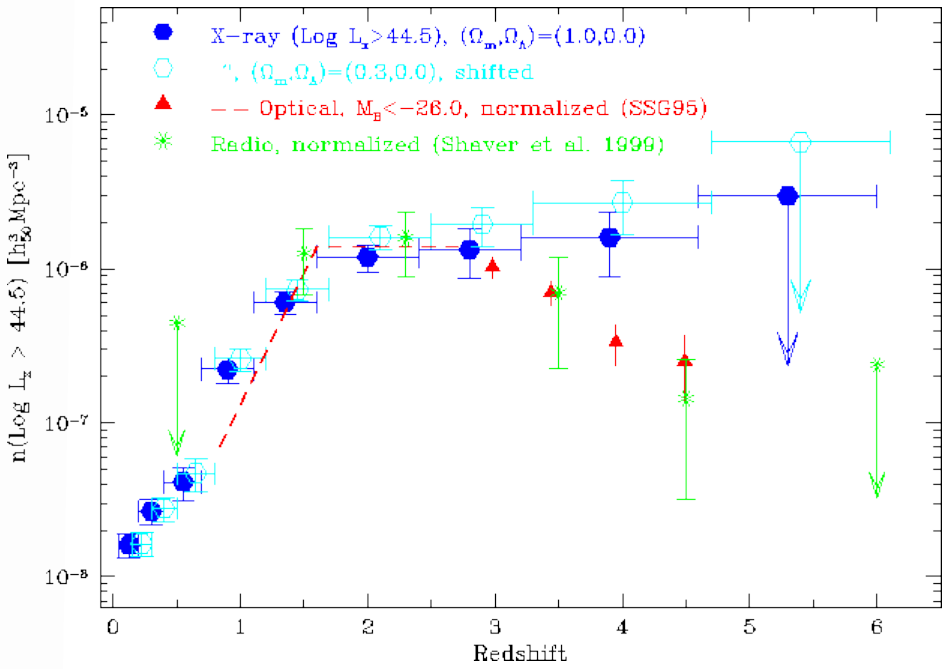


What happened at z~2 ?

- Star-formation Rate
- AGN Population





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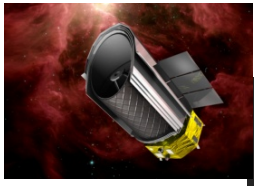
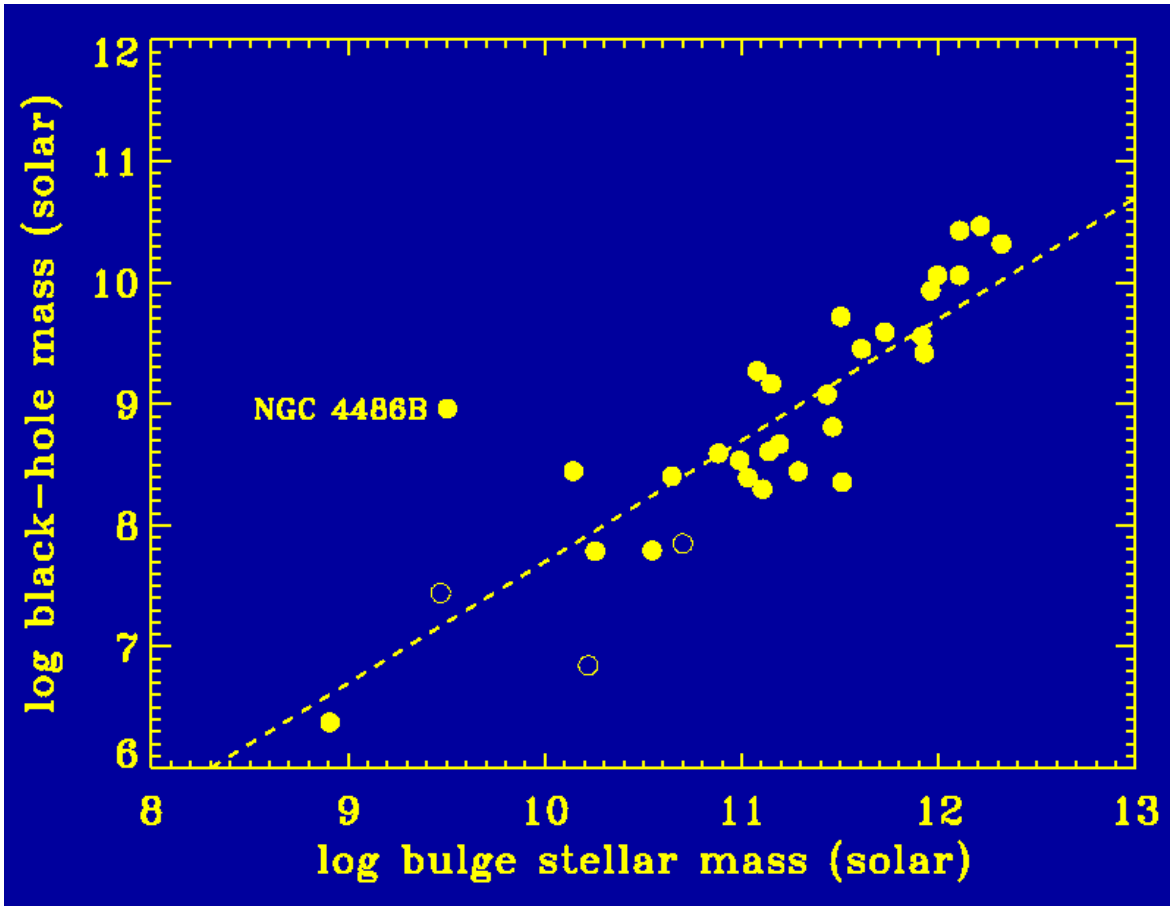


What makes this relation ?

- Stars
  - Starburst
  - $E/mc^2 \sim 0.005$
- Super Massive BH
  - Active Galactic Nuclei (AGN)
  - $E/mc^2 \sim 0.1$



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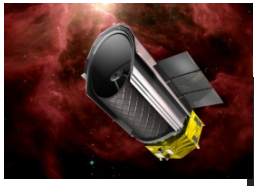
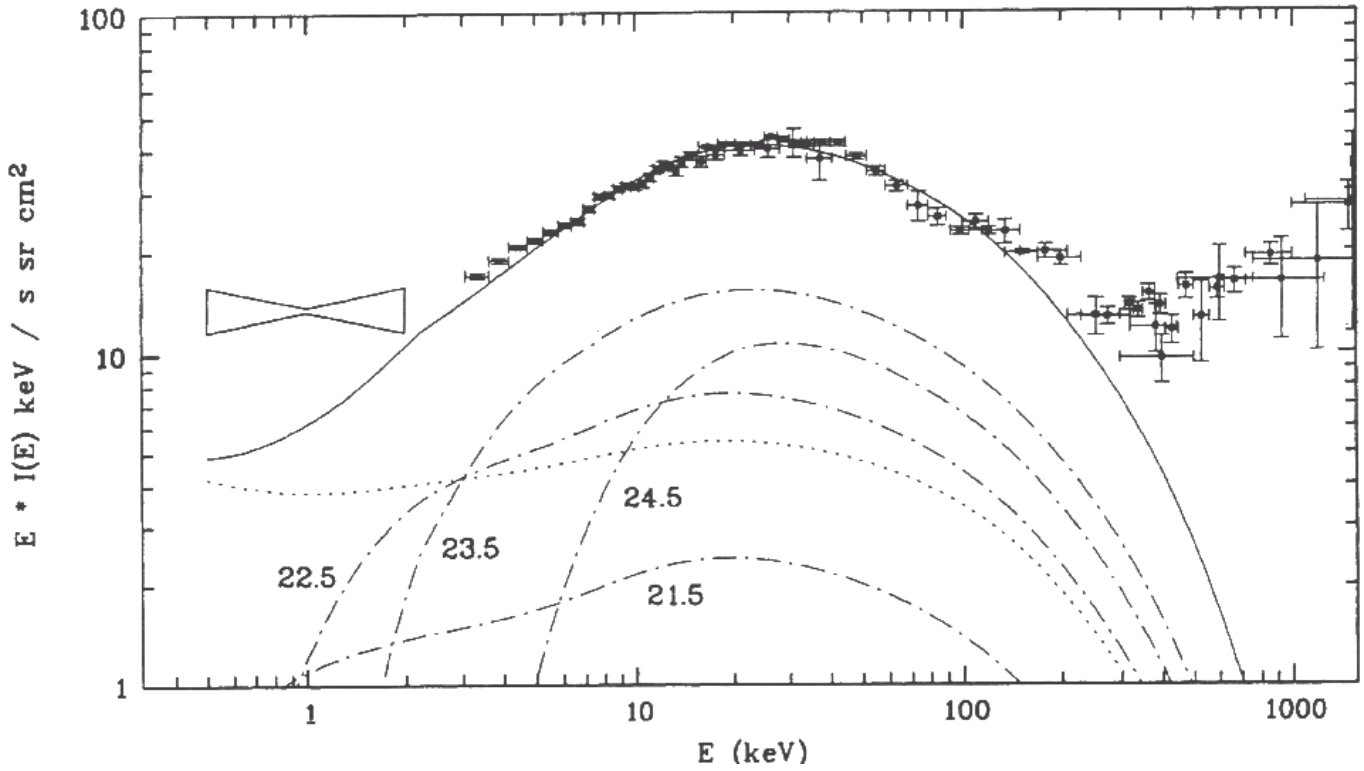
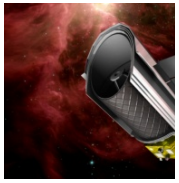


Importance of obscured population

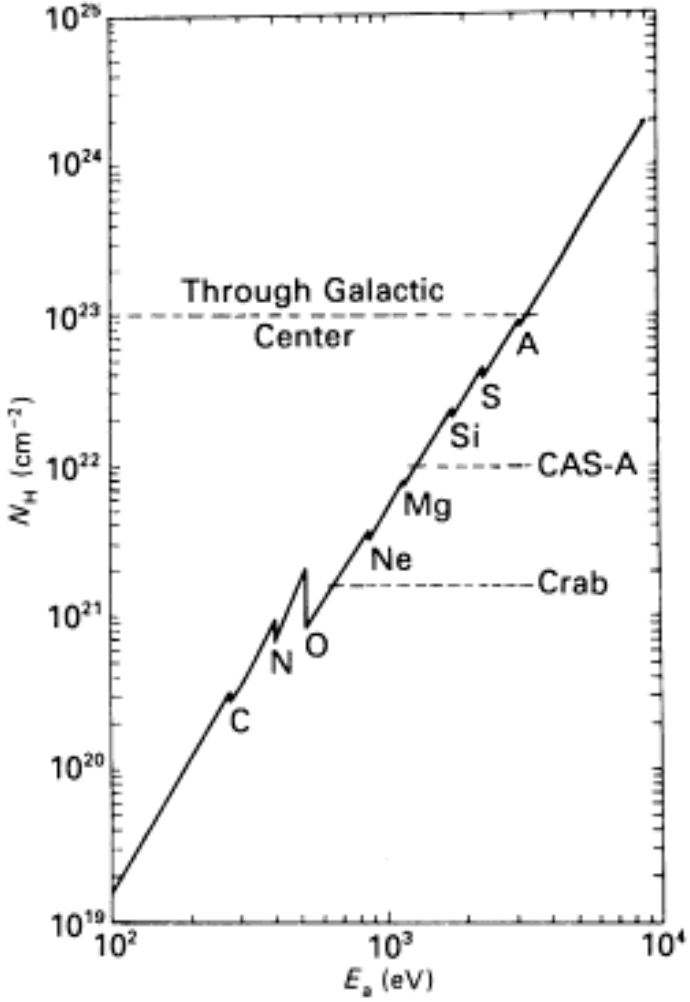
- Obscured AGN population required to explain CXB



SPI
Space Infrared Telescope for



How deep can we see ?



← Far-IR

← Mid-IR

← Near-IR

← Optical

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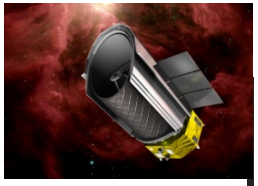
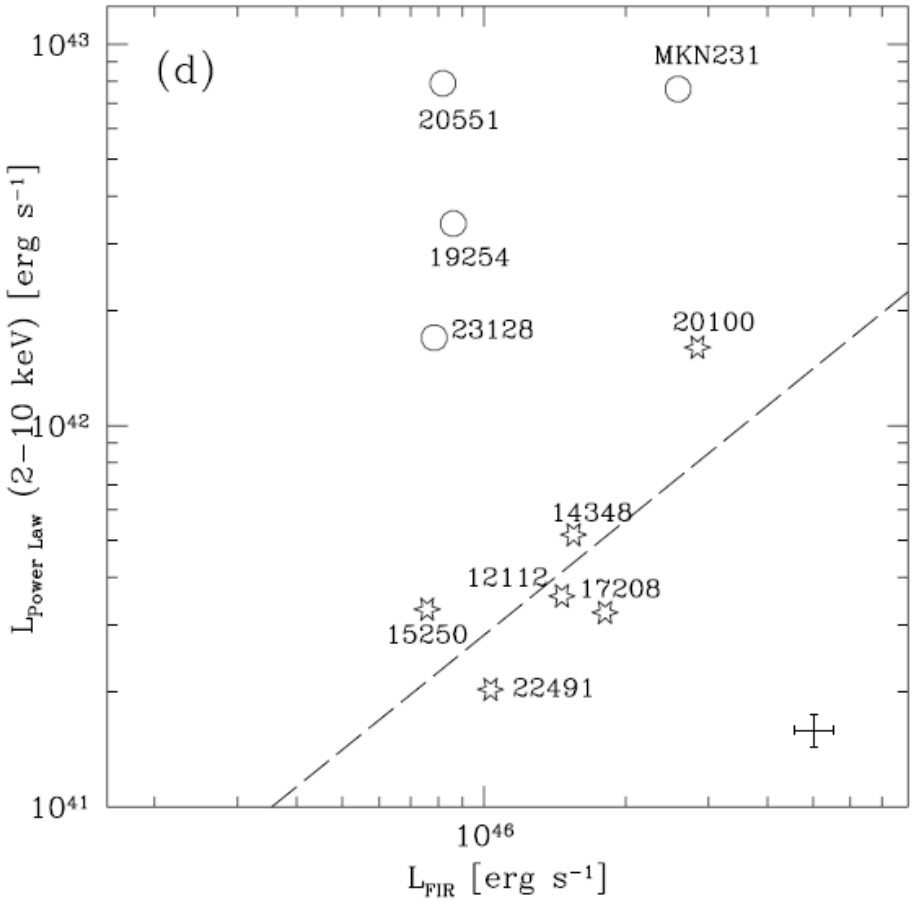


X-ray vs IR



- ULIRGs (mostly starbursts) are weak X-ray emitters
  - Franchescini et al. 2003
- IR: starburst sensitive
- X-ray: AGN sensitive

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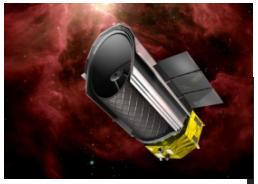
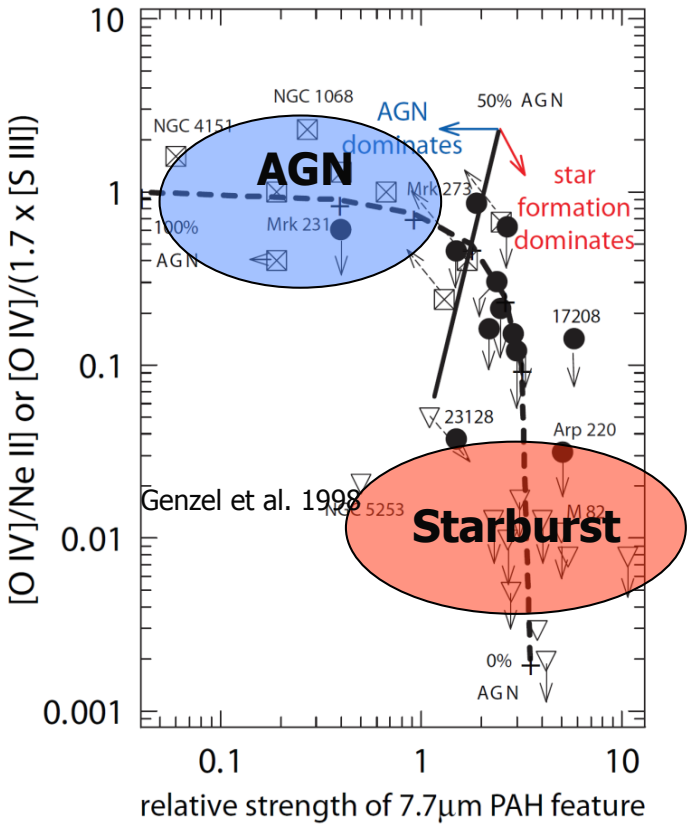
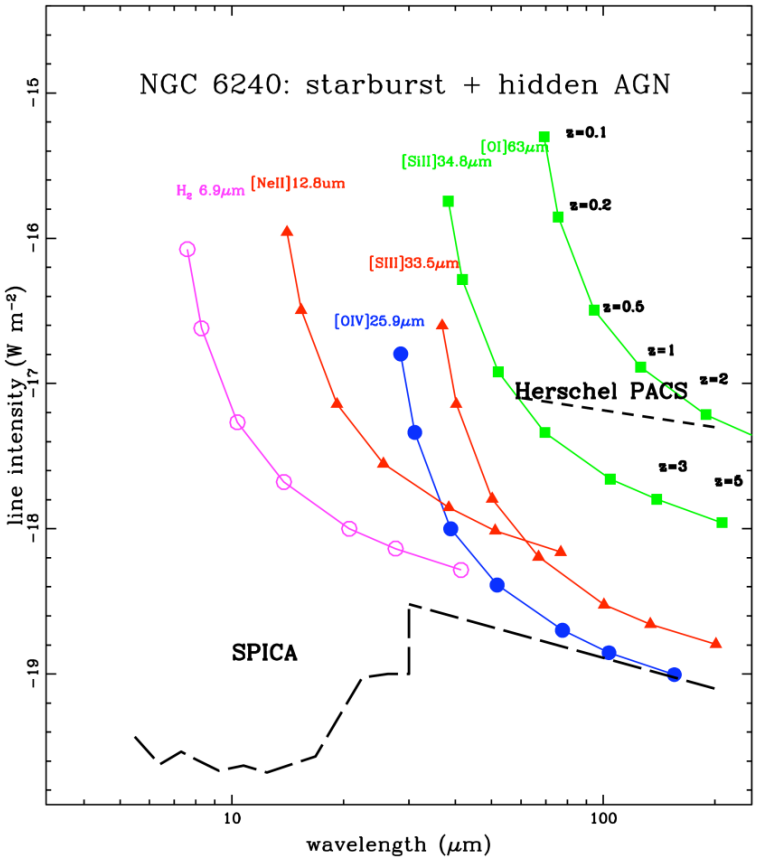


IR spectroscopy →Energy Sources





- Effective tool to this identify energy sources
- Effective also for obscured sources

Spinoglio et al 2009

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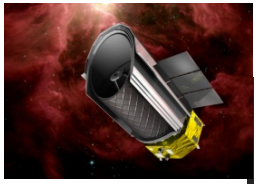
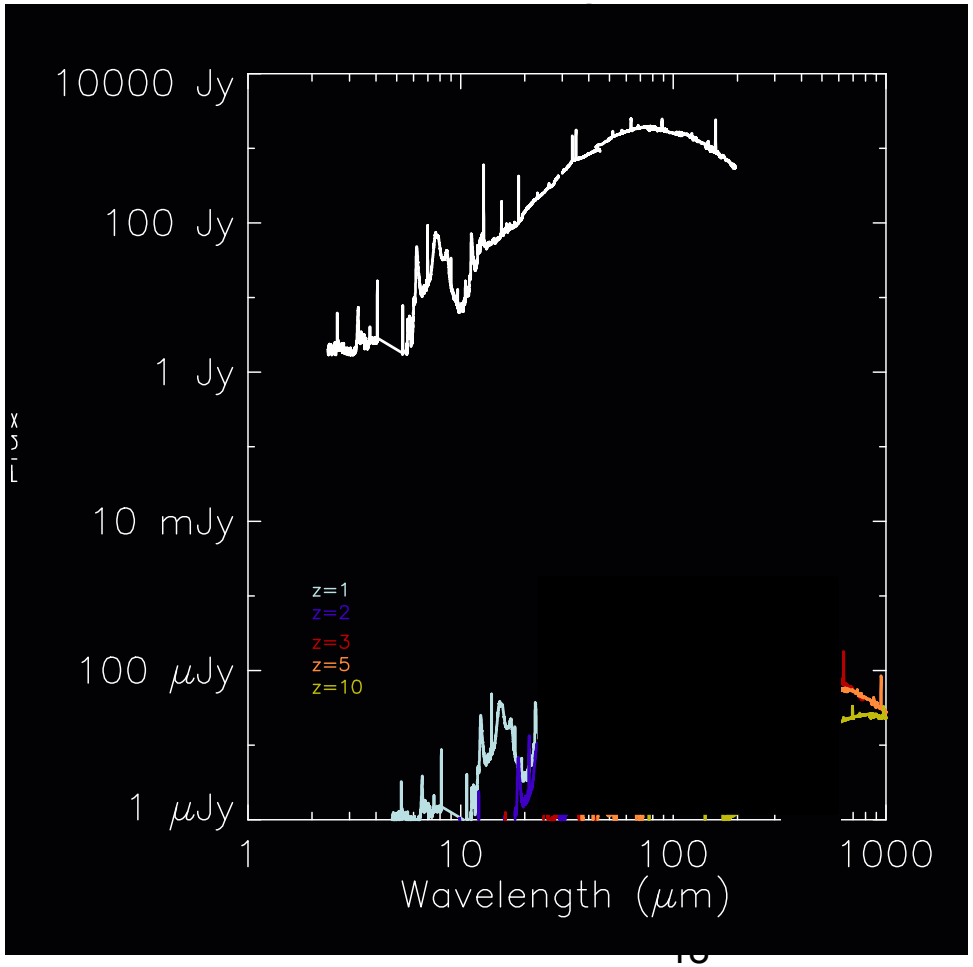
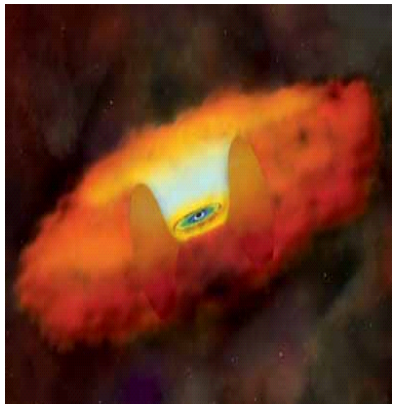


Characterize high-z galaxies

Herschel and SCUBA-2 → many objects in photometric surveys

Only **SPICA** can reveal nature and role of AGN and star





To reveal their nature and physics and chemistry

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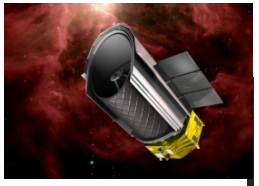
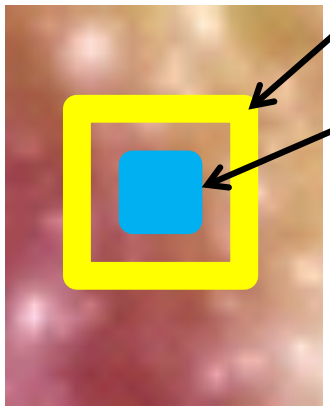


Cosmological Spectroscopoic Survey

900 hours
Of Obs.



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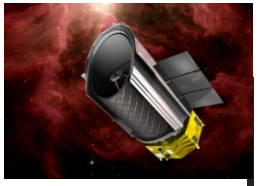

Cosmological Spectroscopoic Survey

900 hours
Of Obs.

Large-scale structure

Dark matter vs Barionic Matter

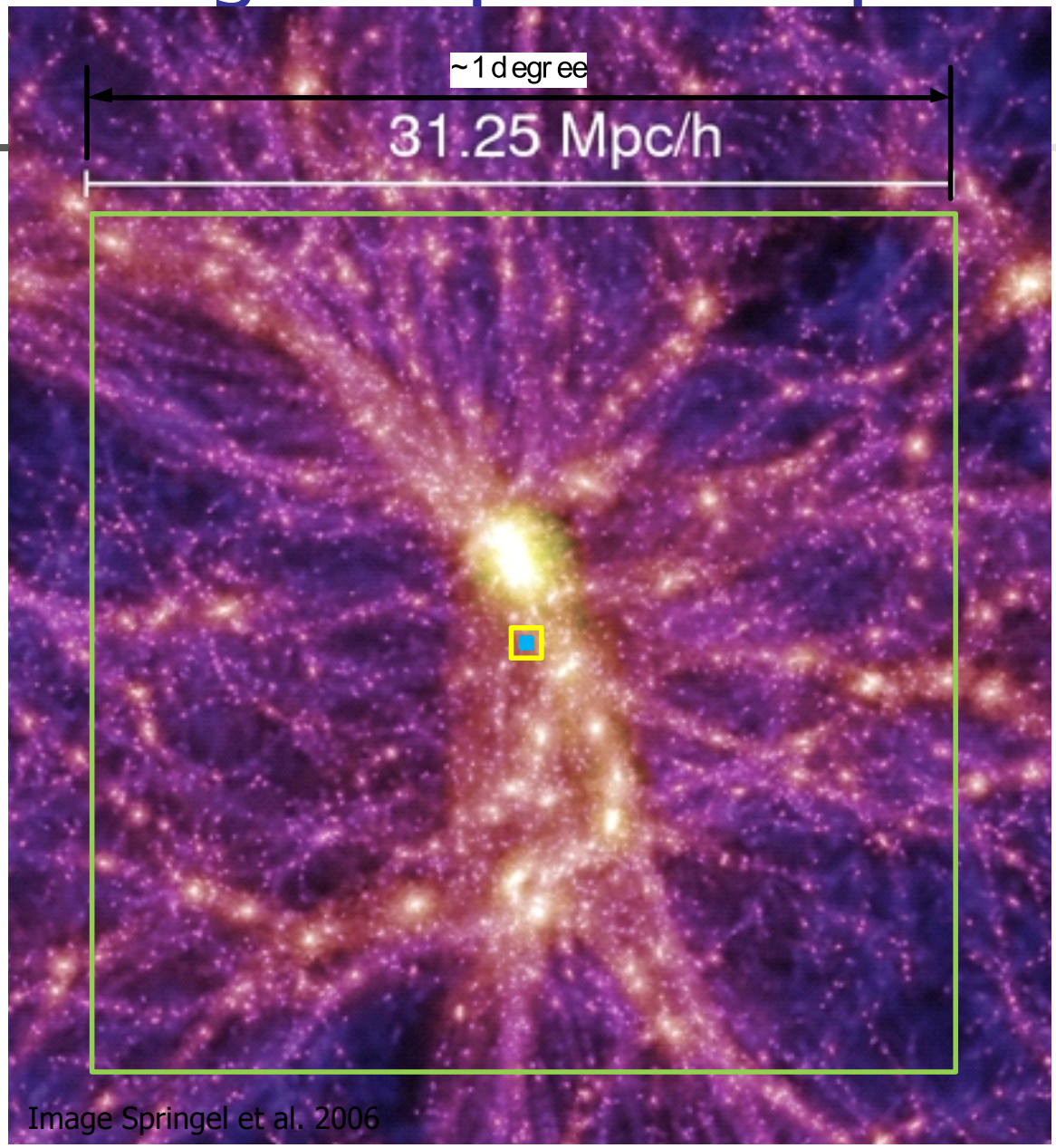

Image Springel et al. 2006

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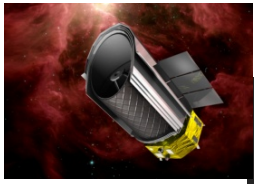
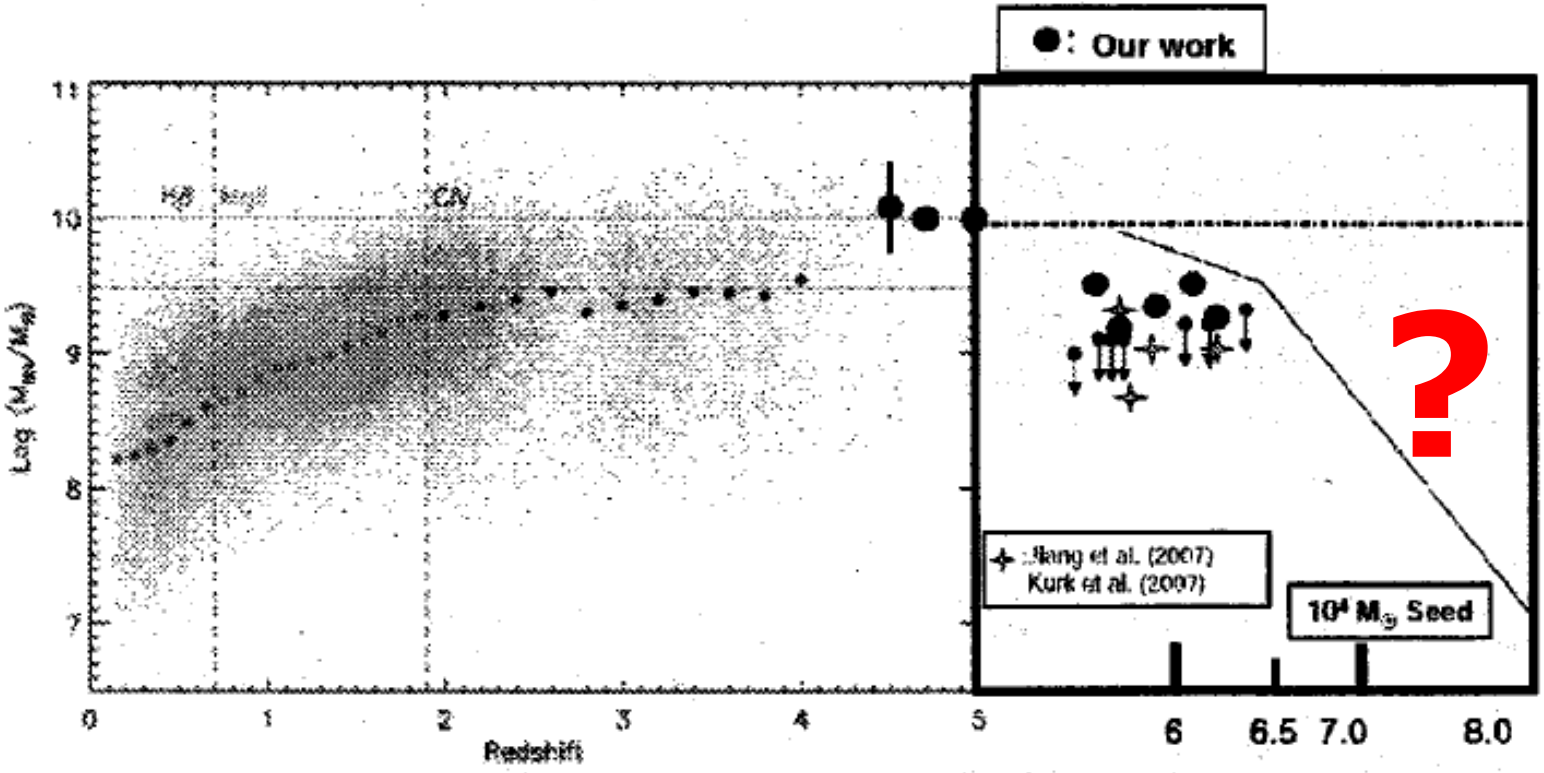


Black Hole Growth: IR View



- Decline of mass at high z ?
  - AKARI results (Im et al. 2010)
  - The next step: SPICA

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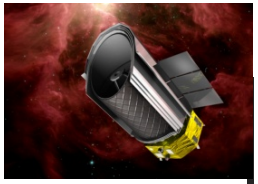
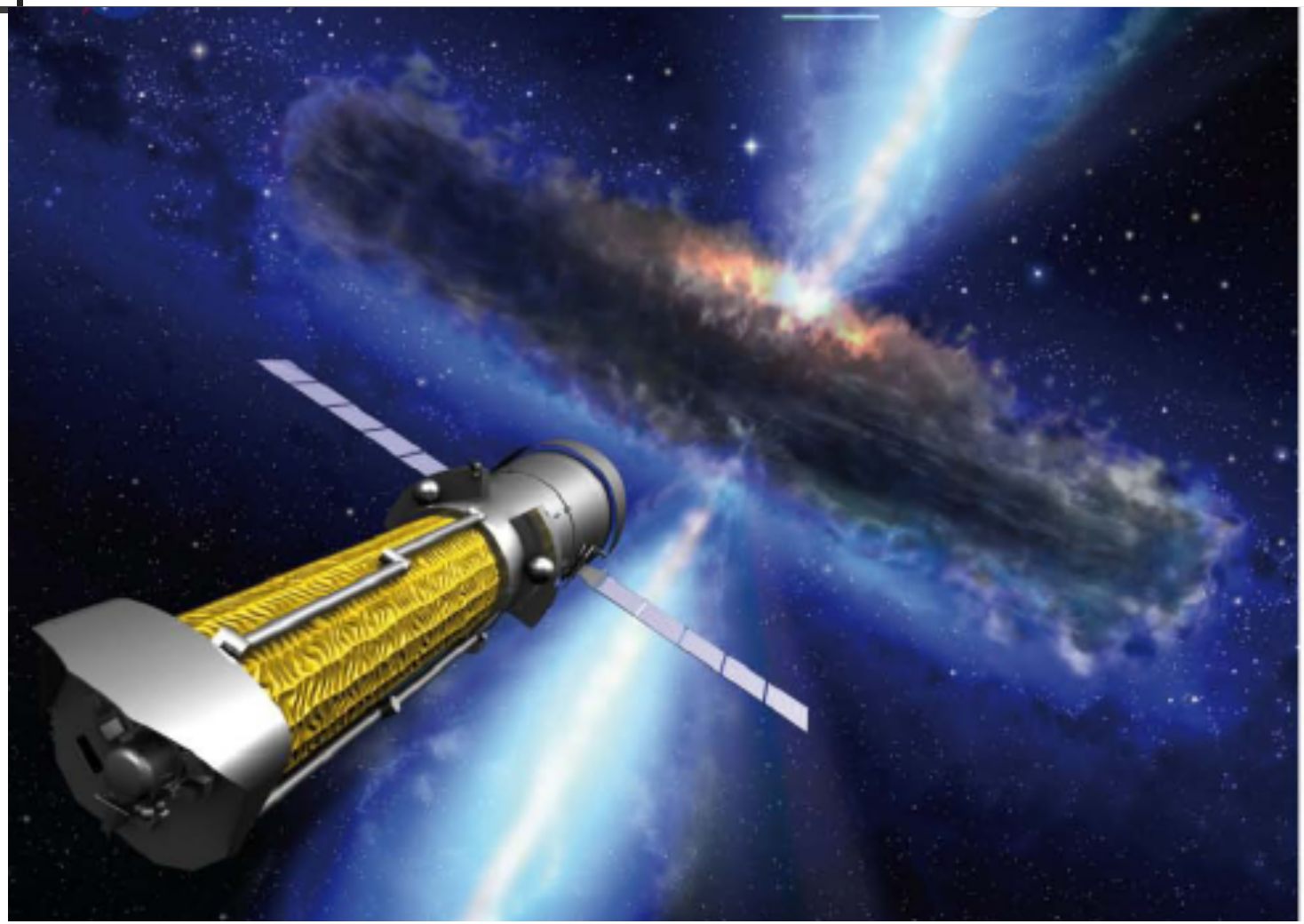


Is “unified scheme” true ?



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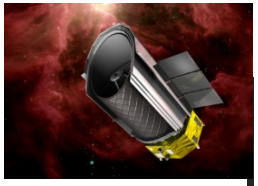
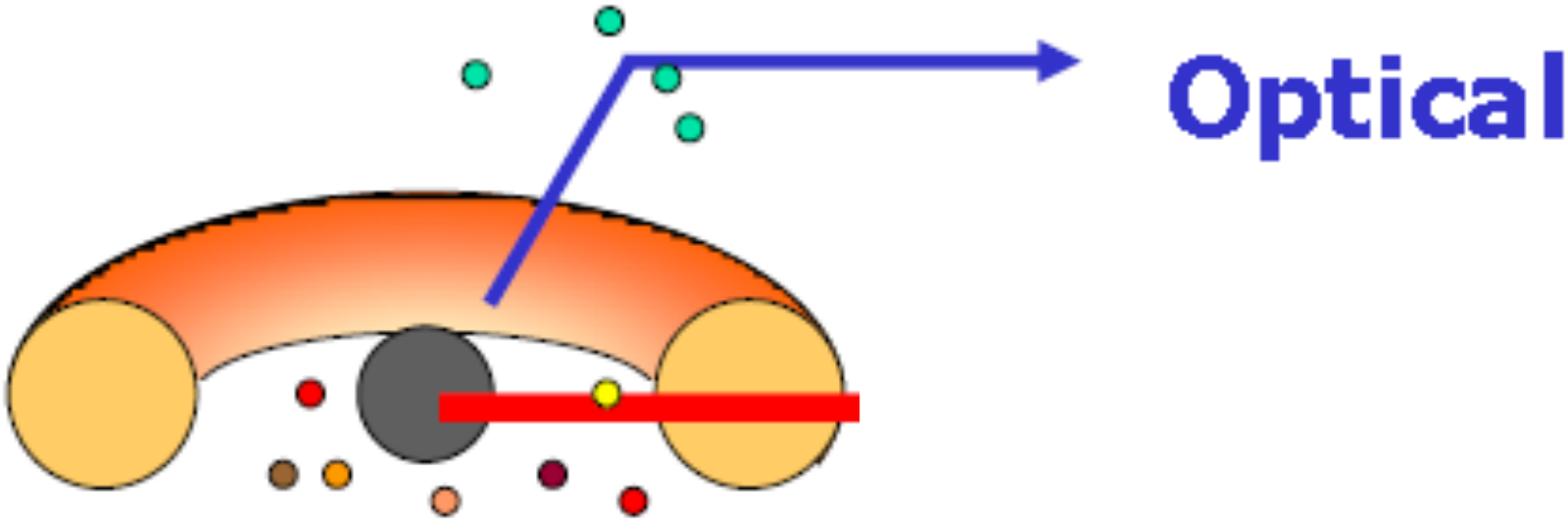


Is "unified scheme" true ?

- Some kind of anisotropy required
  - Is it torus ?
  - To prove physical characteristics of molecular torus tori
  - IR observations of absorption in molecular tori



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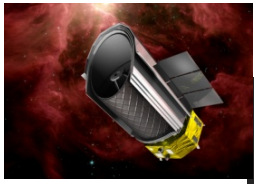
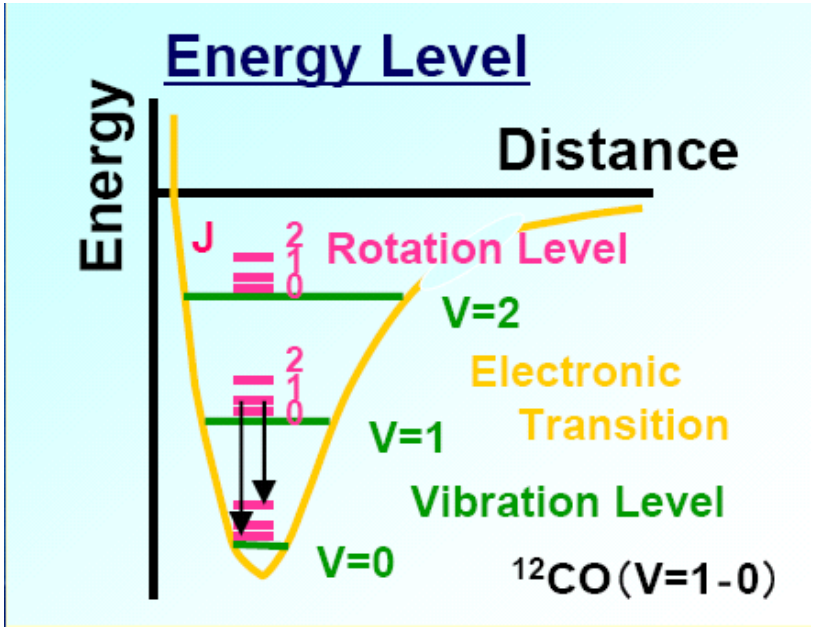
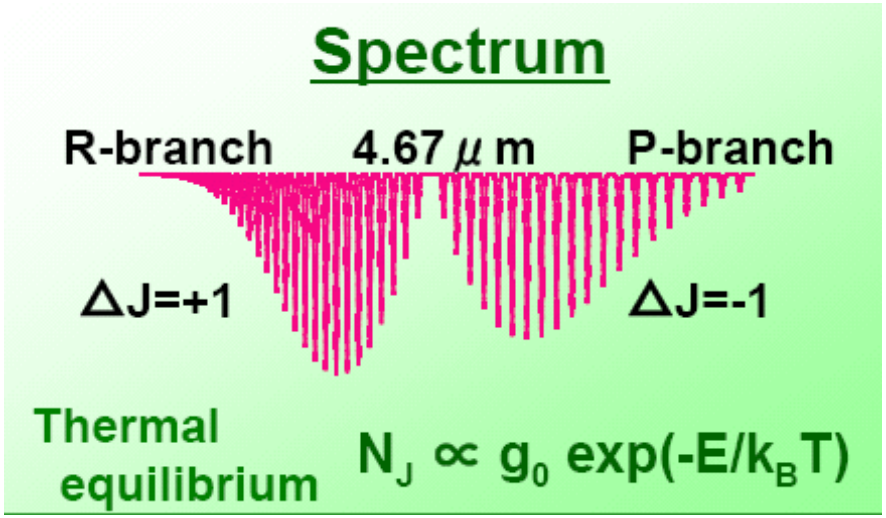


Fundamental ro-vibrational transition of CO

- v=0-1, $\Delta J=\pm 1$ @ 4.6 μm
  - Many lines with different J
    - Temperature, column density
- Background Source
  - Central engine ?

- Merits
  - Multi-line spectroscopy allows to obtain physical conditions
  - Very high spatial resolution





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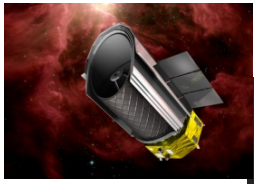
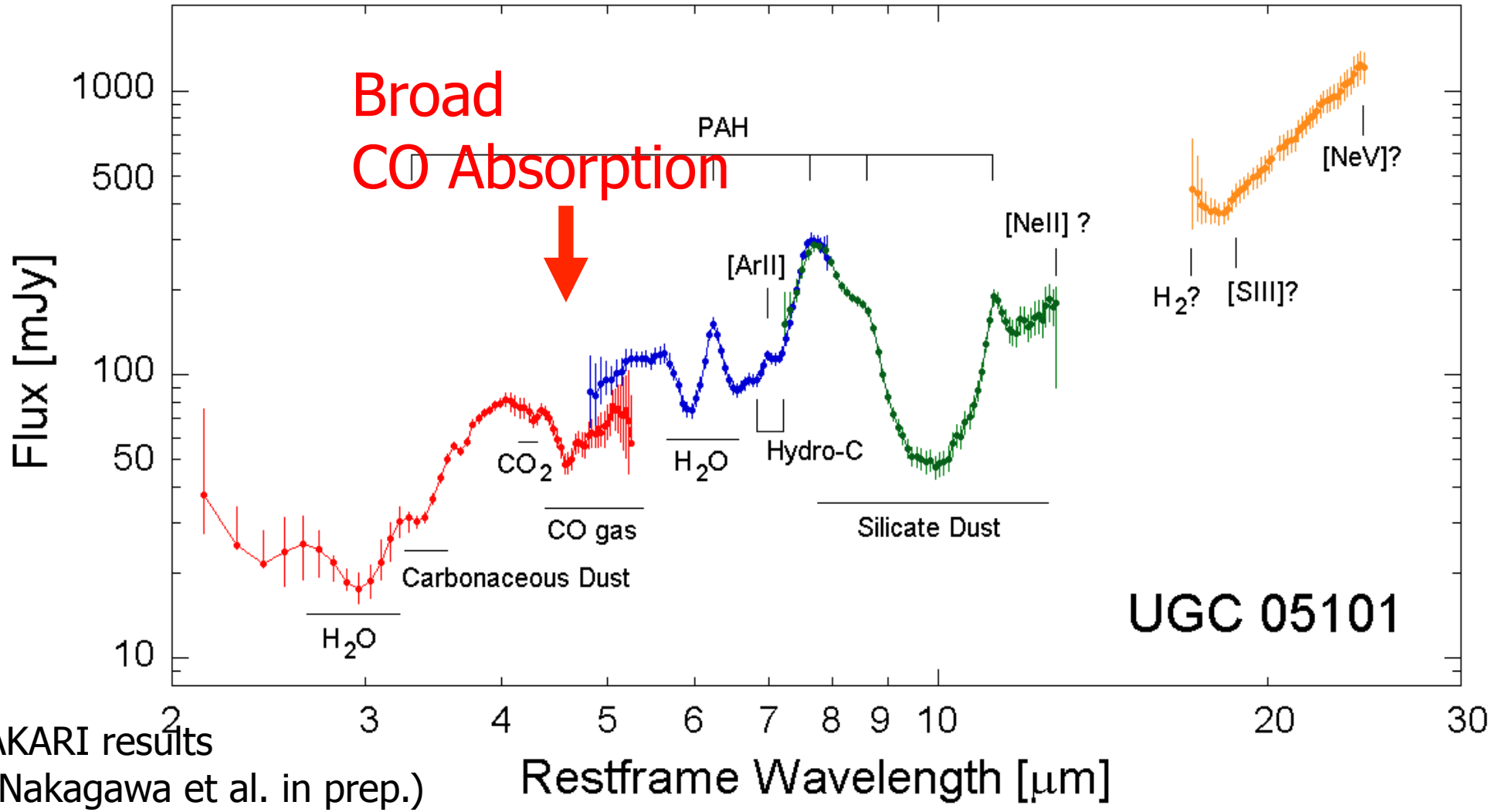
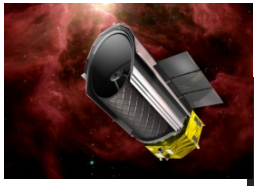


CO Absorption is detected



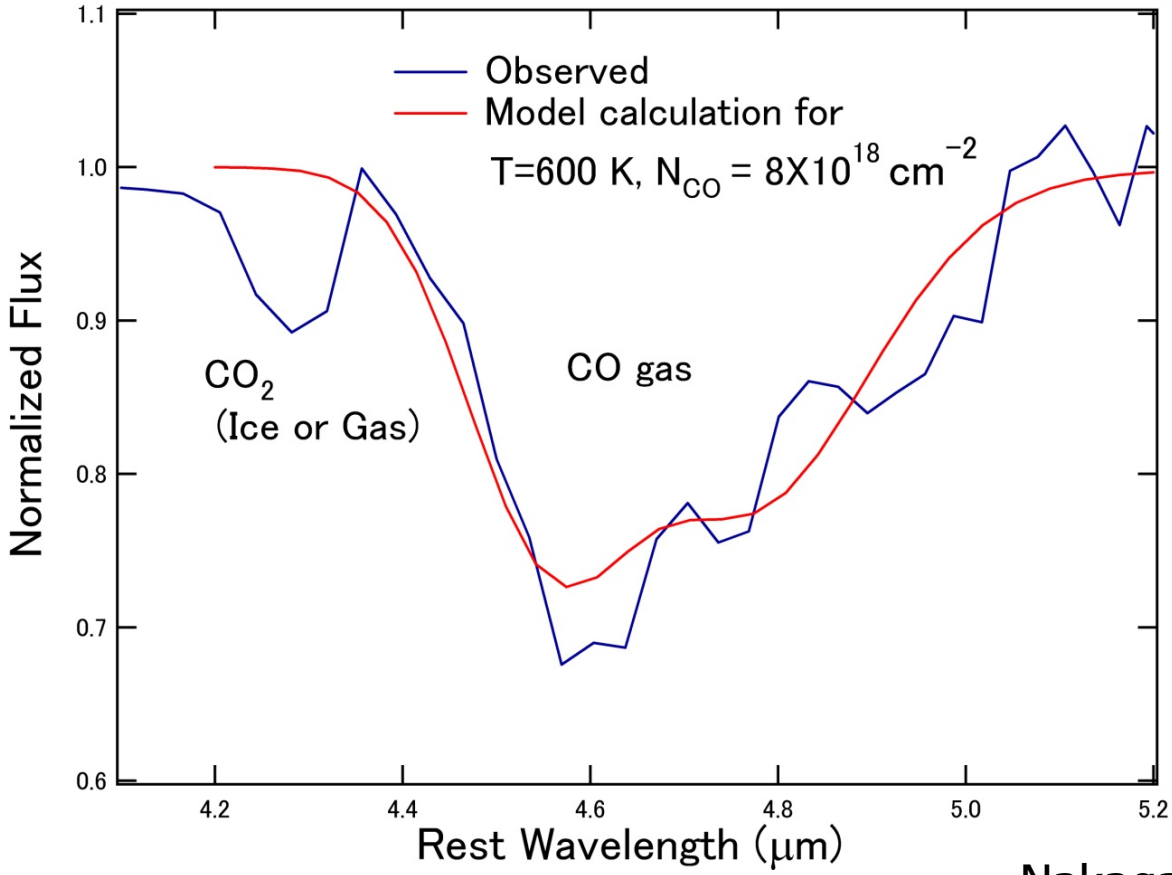
AKARI results
(Nakagawa et al. in prep.)

SPICA
Space Infrared Telescope for Cosmology and Astrophysics



Hot CO gas detected

- Large column density of hot gas



Nakagawa et al. in prep.

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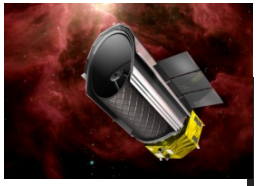
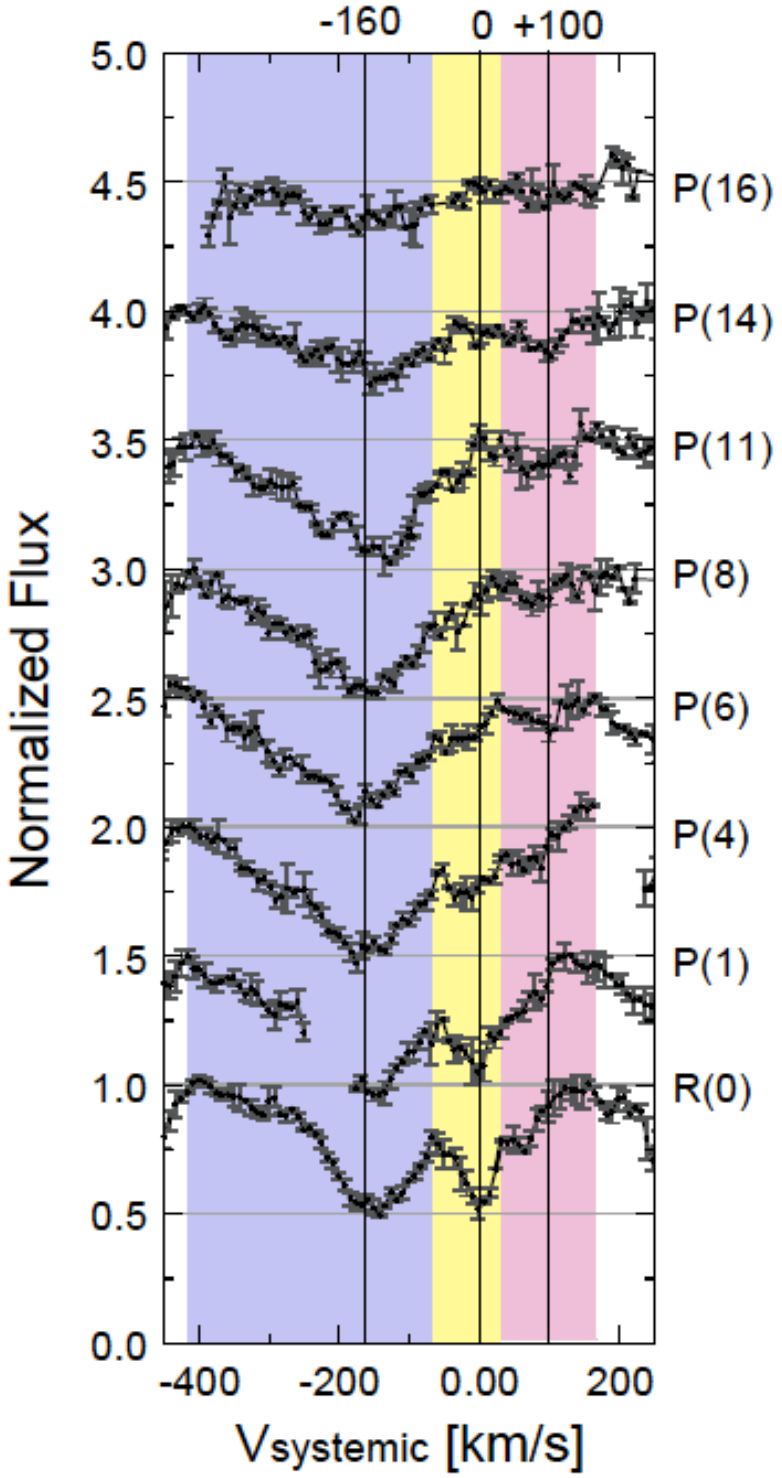


Subaru follow-up

- Several Velocity components
  - The strongest one is blue-shifted (-160 km/s) and hot (~several 100 K)
- Outflowing molecular torus ?



Shirahata et al. submitted

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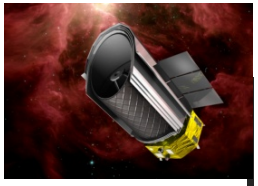
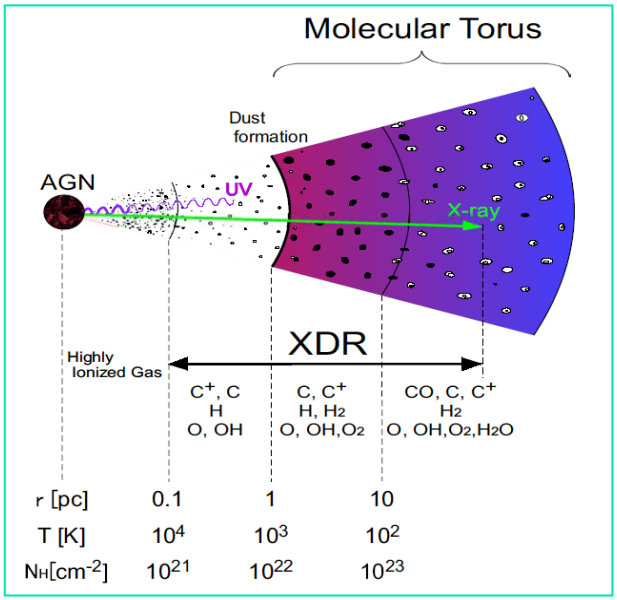


How can it be heated ?

- Observations
  - T=200 - 1000K with
    N_{H2} ~ 3 - 10 X 10^{22} cm^{-2}
    - Av ~ 20-100 mag ?
- PDR ?
  - UV heating
  - Only Av< a few mag for T~1000K
- XDR !
  - X-ray heating (from the central engine ?)
  - Large penetration depth Av > 10 mag
  - Efficient gas heating



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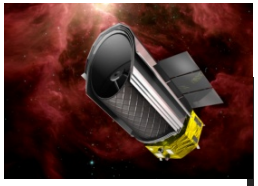

Yet another synergy

- Technical synergy
  - Cryocoolers
    - Mechanical cryocoolers
      - AKARI, Planck, Suzaku heritage
    - Sorption Coolers
      - IRTS, Herschel heritage
    - ADR
      - Suzaku heritage
  - TES detectors

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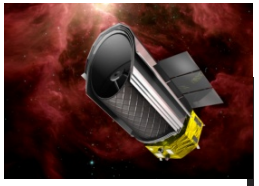

Exciting ERA